Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation

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Main motivations

Assess 9 years of POLDER-3 shortwave fluxes

- Viollier et al., 2002 → Shortwave fluxes from POLDER observations
- POLDER is a spectral radiometer: need to compare the results to an ERB-dedicated instrument

Prepare for upcoming mission

Fig. 1: 3MI instrument, illustration (credit ESA)

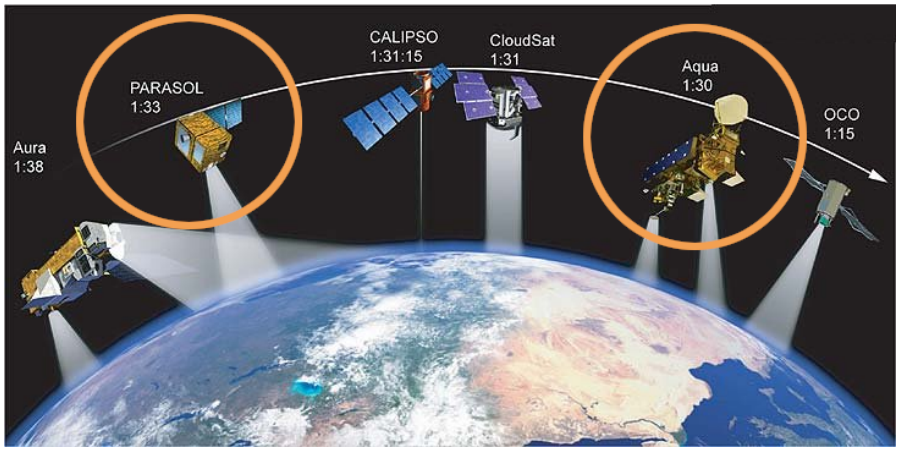
- POLDER heritage instrument: 3MI (Fougnie et al., 2018)
- Multi-Viewing Multi-Channel Multi-Polarization Imager
- Three instruments (2024, 2030, 2037) → 20+ years of measurements
- Could benefit from the results of this study

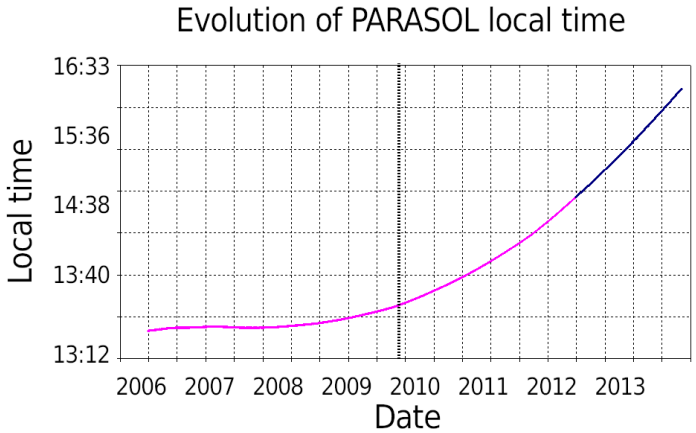
POLDER-3/PARASOL

PARASOL mission

- Mission was to last from 2005 to 2007 → 2005 to 2013
- Flew in the Afternoon Train along Aqua
  → Coincident measurements with CERES/Aqua for 2005-2009
- December 2009: PARASOL moved out of the A-Train → Local time of measurement changed along with Solar Zenith Angle (SZA).

PARASOL 1:33 pm Aqua 1:30 pm

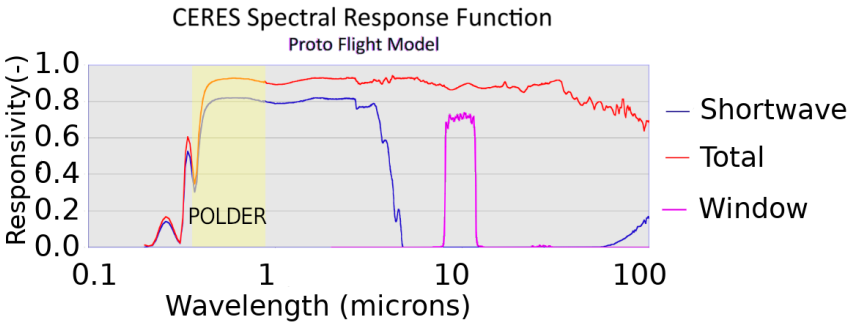




→ Impacted the computation of monthly means of SW fluxes

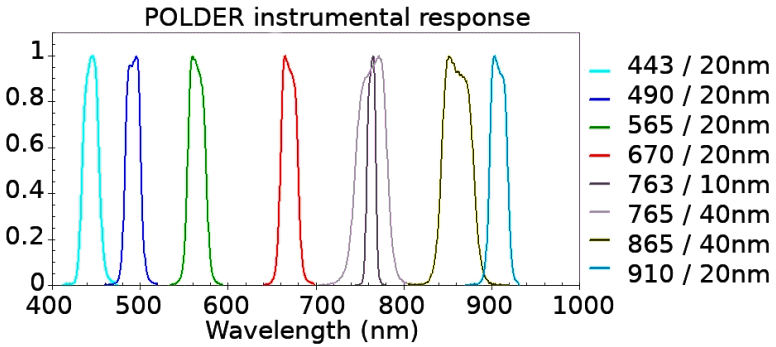
ERB-dedicated vs non-dedicated instruments

Clouds and the Earth's Radiant Energy System



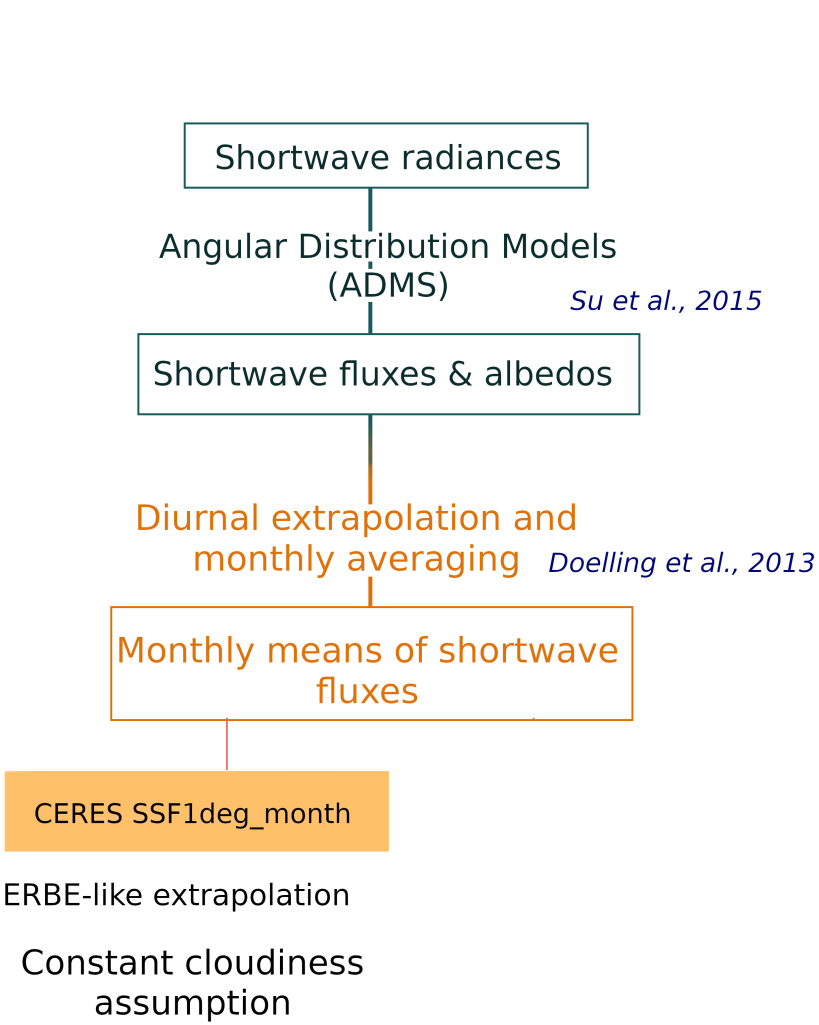
- SW Channel: 0,3-5µm
- TOT Channel: 0,3-100µm
- WN Channel: 8-12 µm

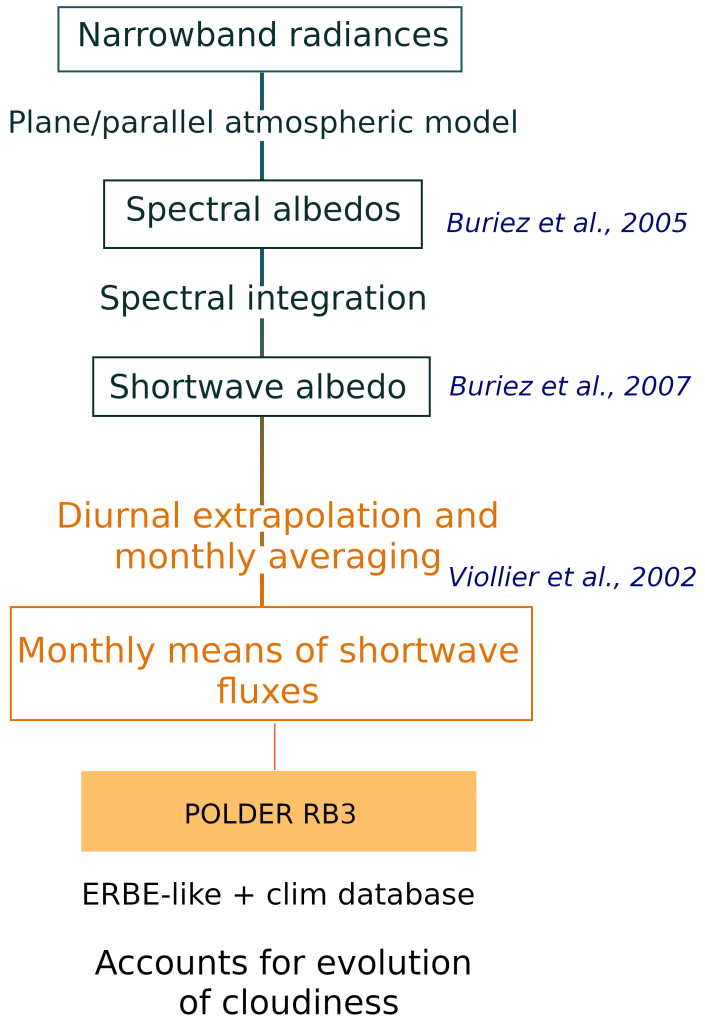
POLarization and Directionality of the Earth's Reflectances System



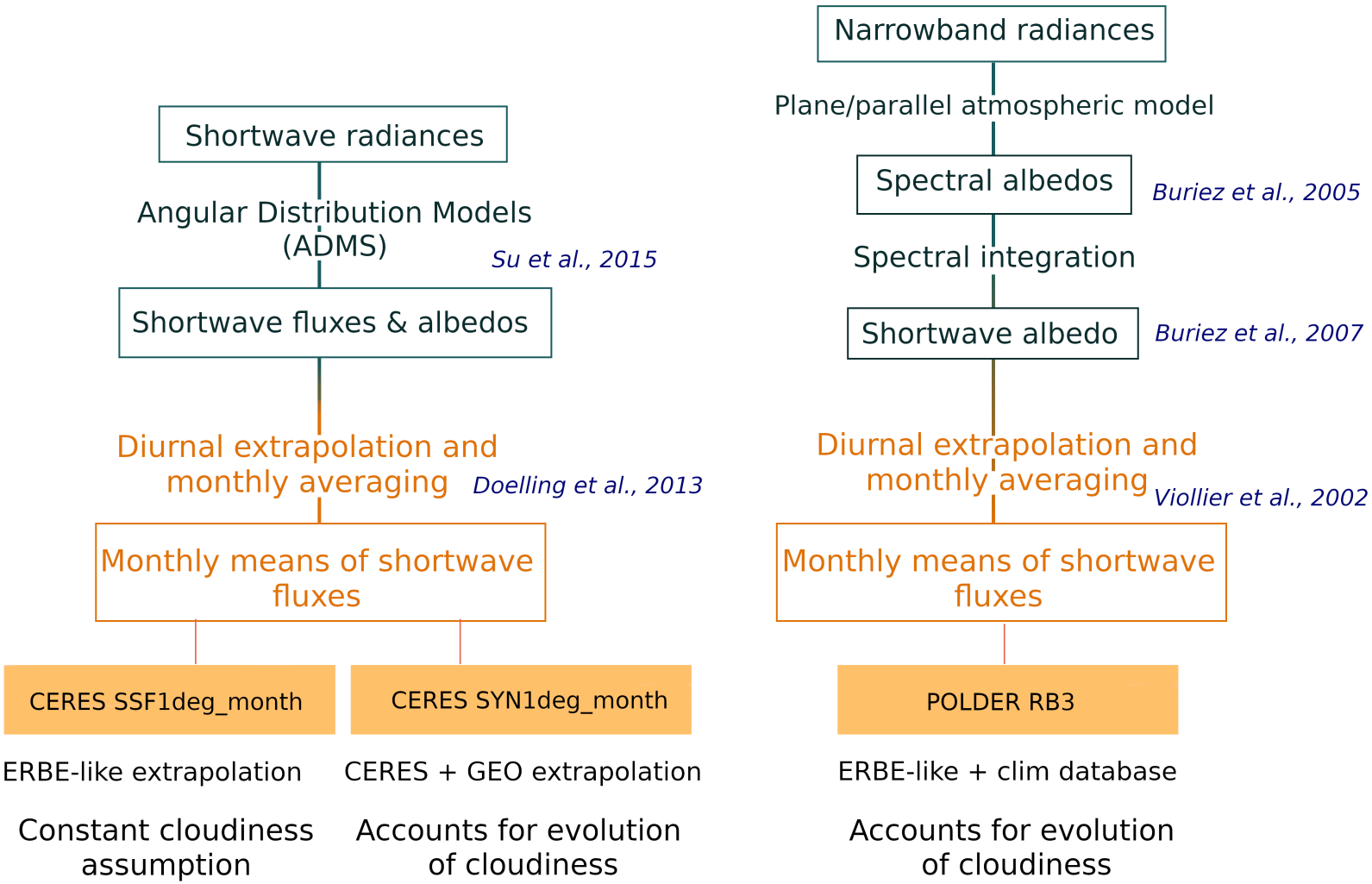
- Spectral radiometer:
  9 channels
- Multidirectionality : → 16 viewing directions
- Polarization state for 3 channels

Monthly means of shortwave fluxes



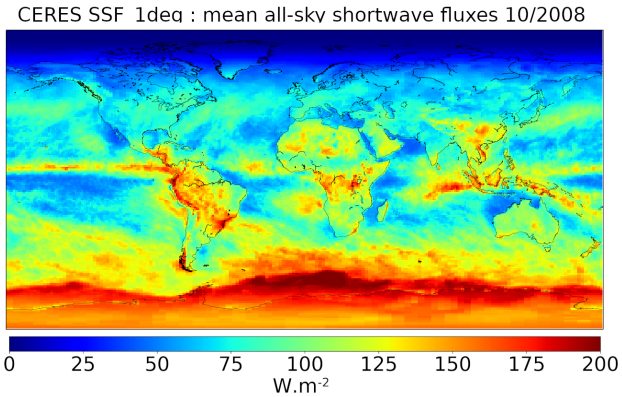


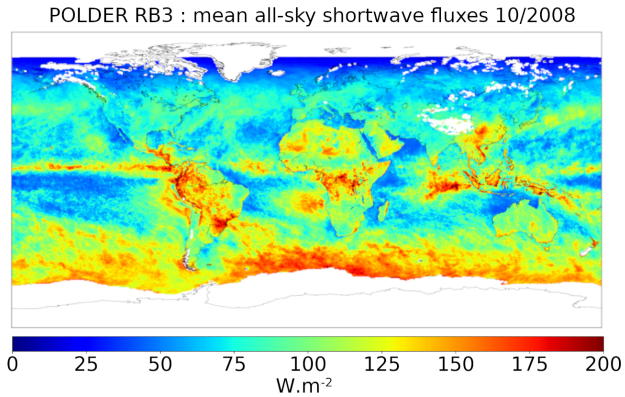
Monthly means of shortwave fluxes



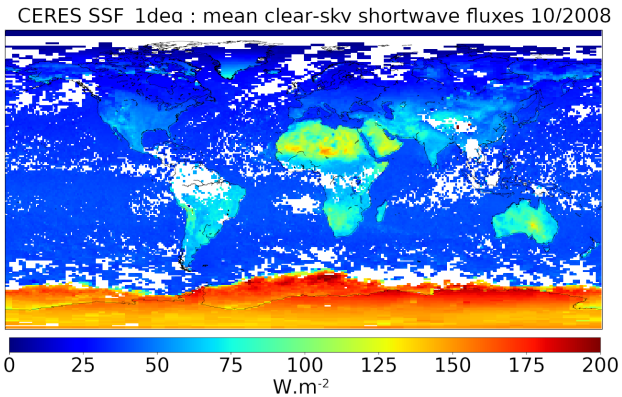
Shortwave fluxes POLDER/PARASOL and CERES/Aqua (SSF1deg)

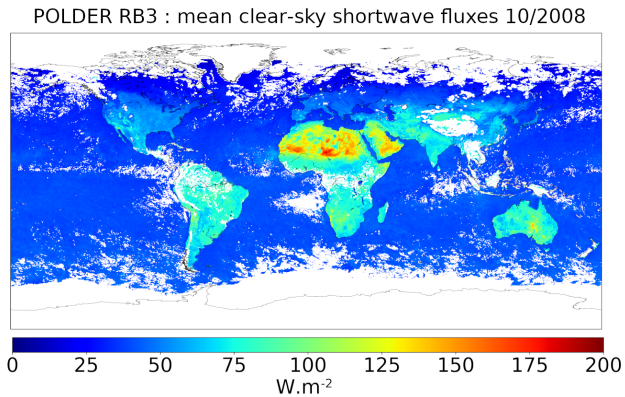
All Sky





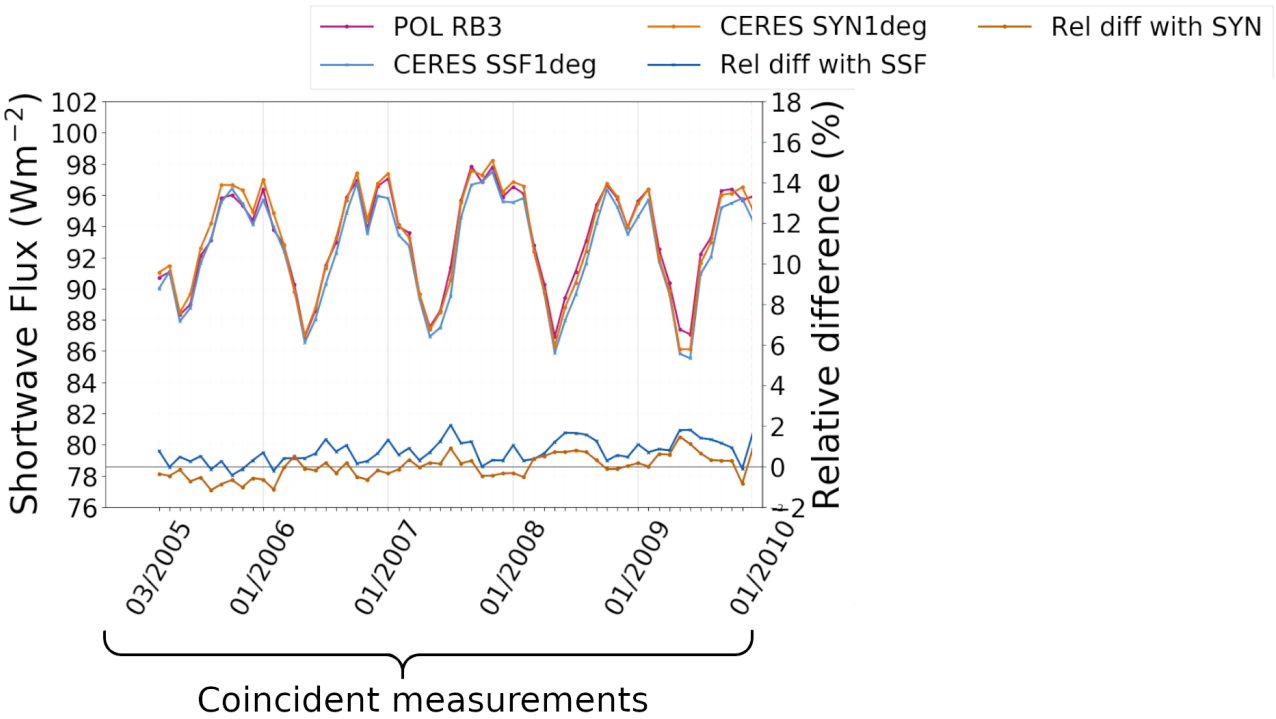
Clear Sky





POLDER RB3, CERES SSF1eg Aqua and CERES SYN1deg Aqua+Terra

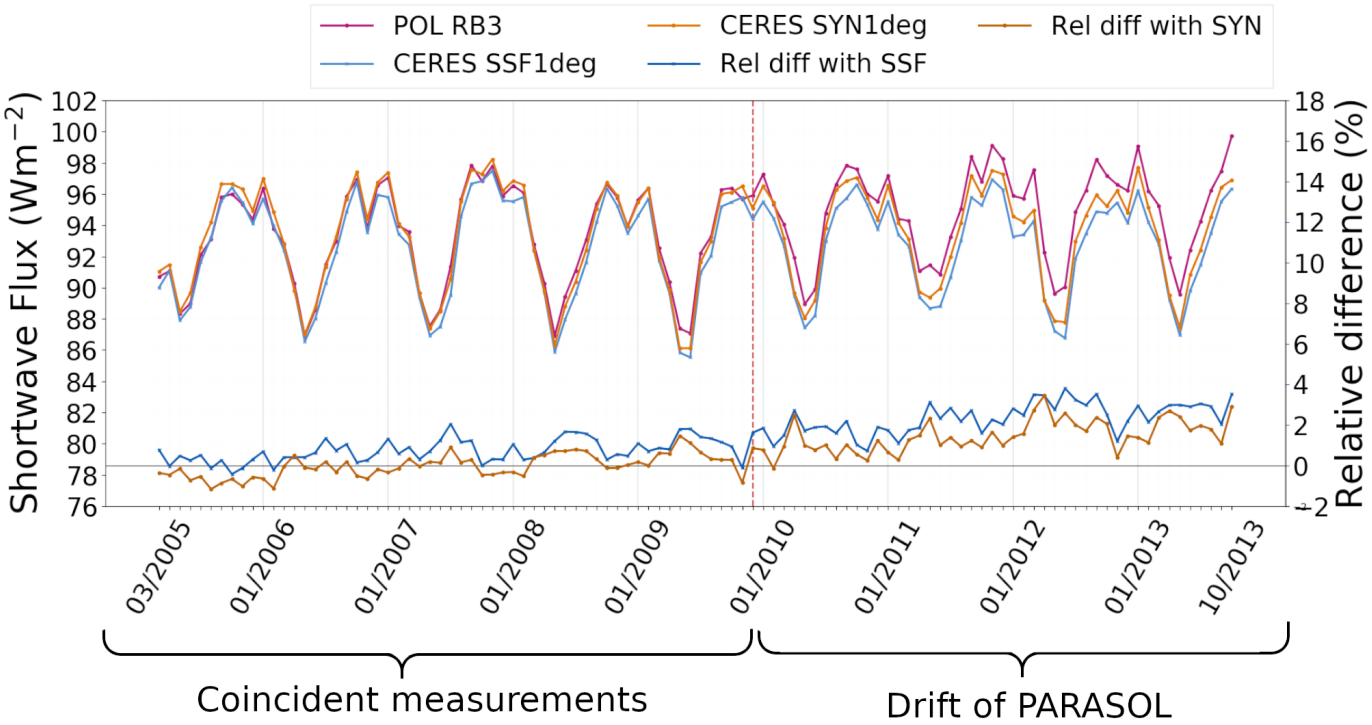
Spatial averaging of 20°N-20 °S lat. belt



- Good agreement (<2%) when the measurements are coincident

CERES and POLDER shortwave fluxes

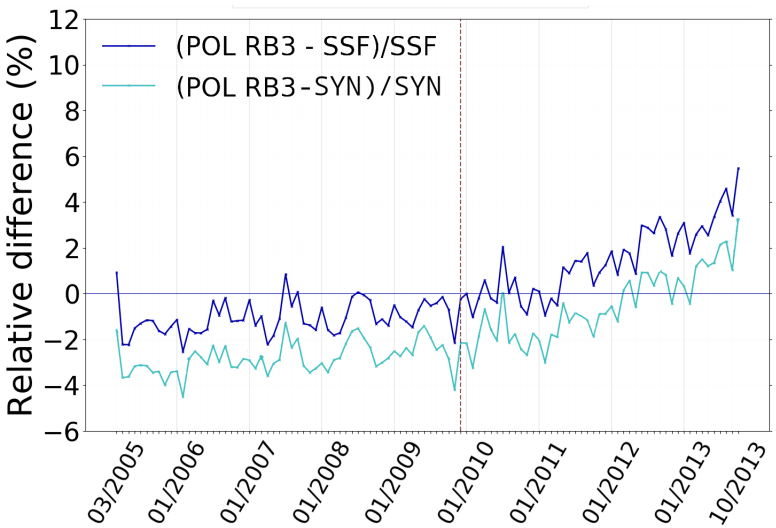
Spatial averaging of 20°N-20 °S lat. belt



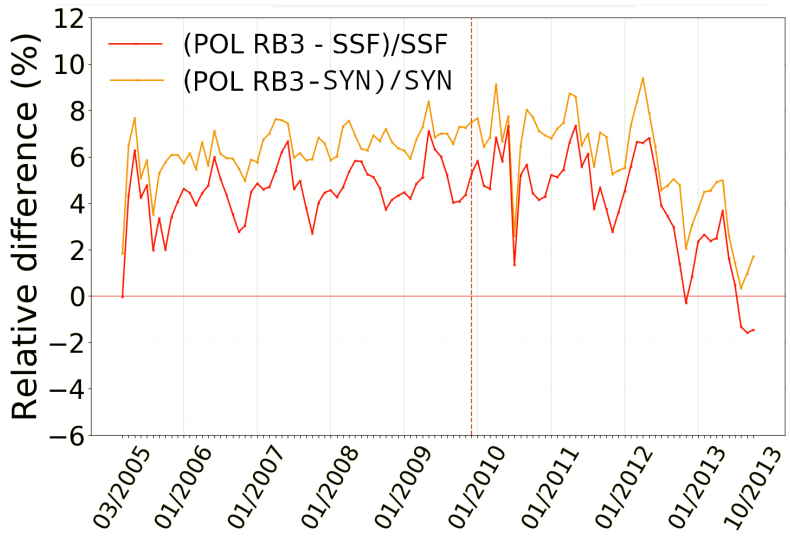
- Good agreement (<2%) when the measurements are coincident
- Values drift when PARASOL's orbit is lowered

Differences over land/ocean

Relative difference POLDER RB3, CERES SSF1deg and CERES SYN1deg:



Over oceans

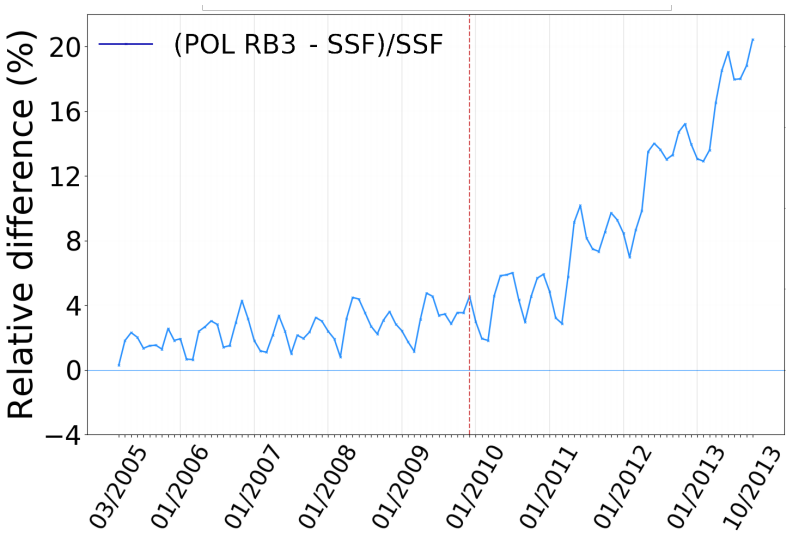


Over lands

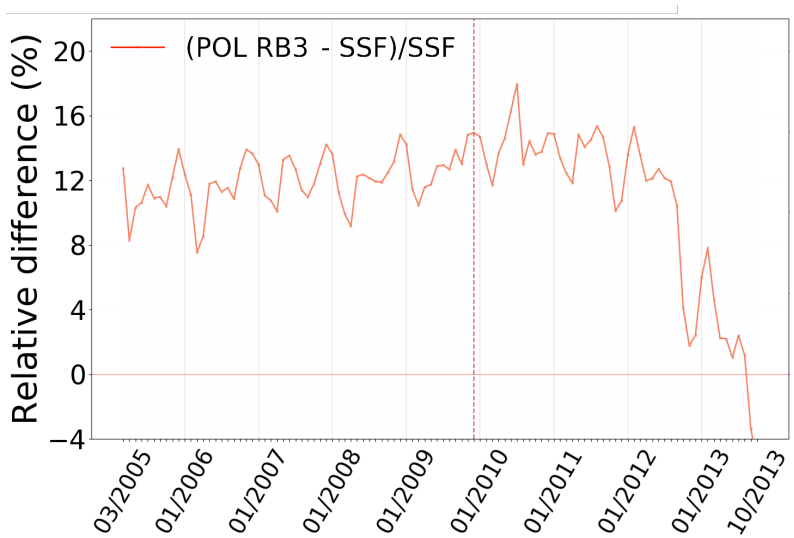
- Compensation effect: behaviour different over land / over ocean
- Differences higher with SYN1deg than with SSF1deg

Differences over land/ocean

Relative difference POLDER RB3, CERES SSF1deg and CERES SYN1deg:



Over oceans



Over lands

- Compensation effect: behaviour different over land / over ocean
- Differences for clear-sky fluxes higher than for all-sky fluxes.

Regional differences

- Same behaviour: increase over oceans, decrease over lands;
- Differences exist for cloudy regions.

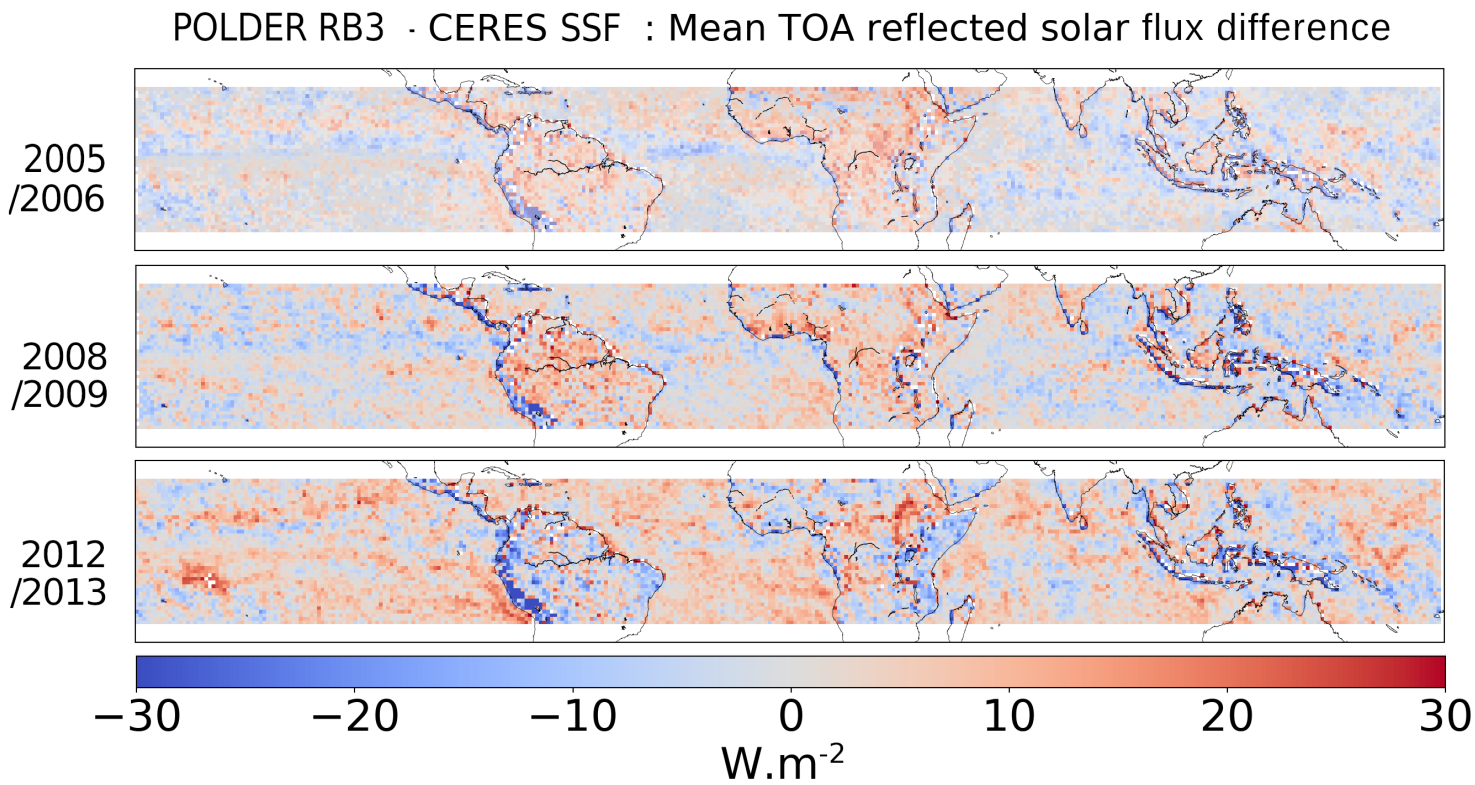


Fig. 2: Differences for an average of December, March, June, September.

Regional differences

- Same behaviour: increase over oceans, decrease over lands;
- Differences exist for cloudy regions.

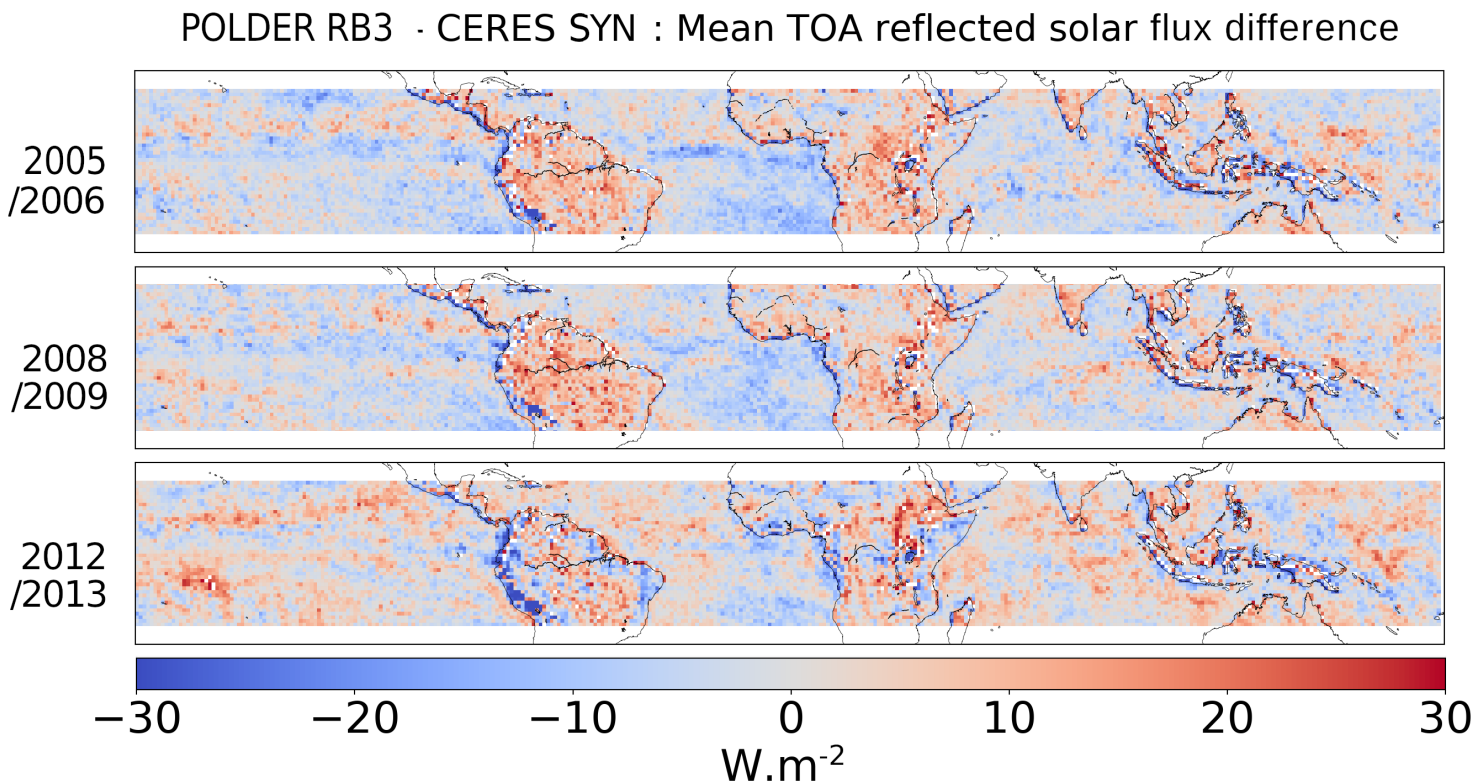


Fig. 3: Differences for an average of December, March, June, September.

Regional differences: clear sky

- Small differences over oceans in 2005/2006;
- Very high differences over bright deserts !

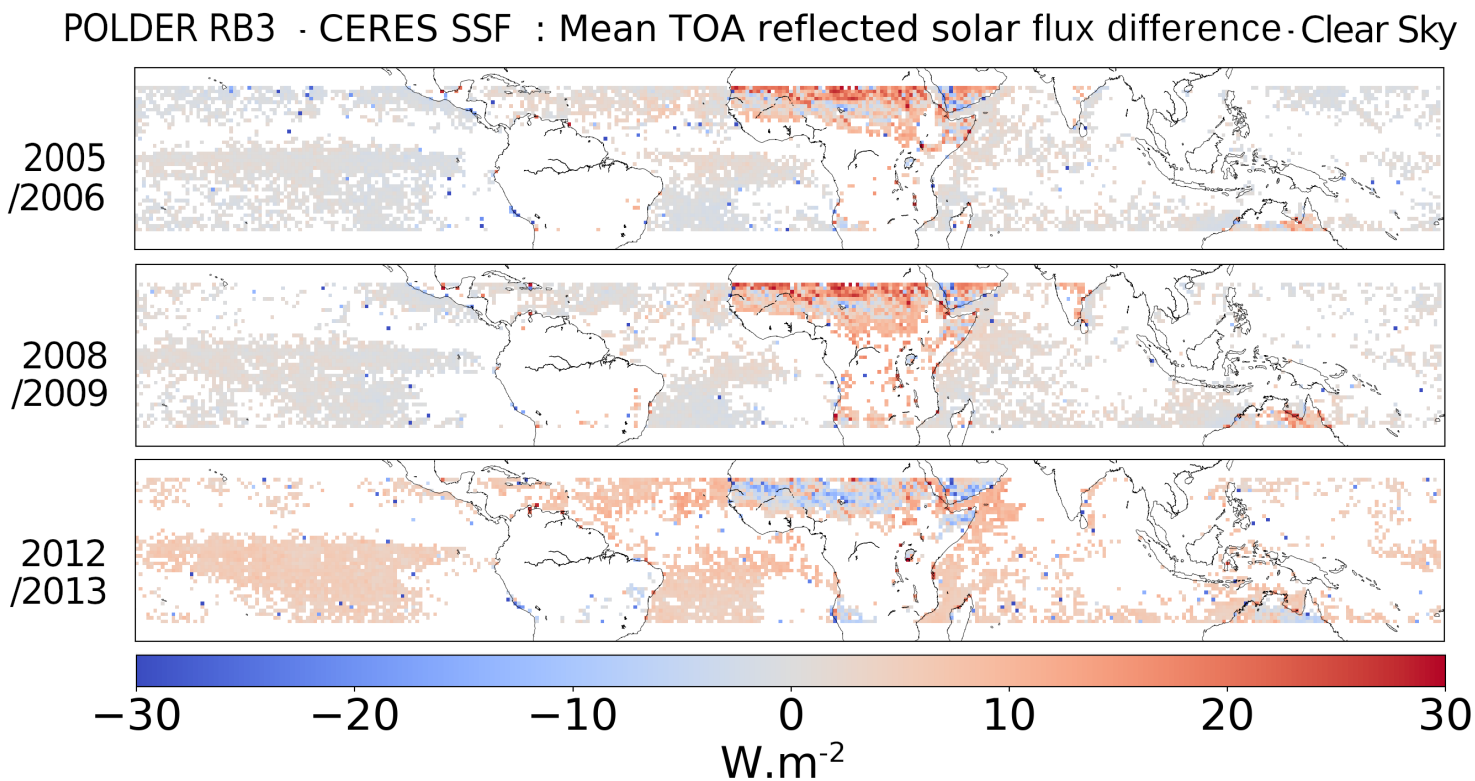
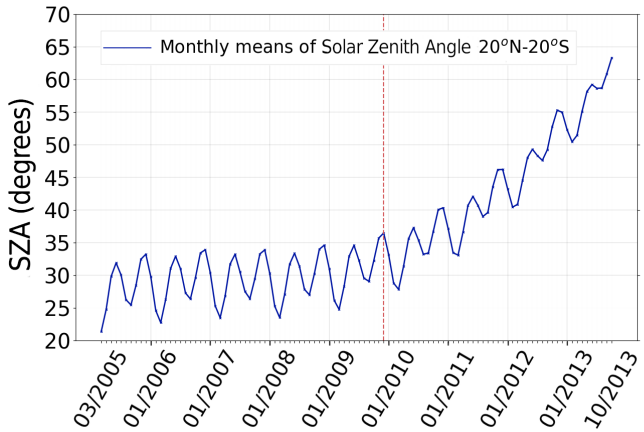
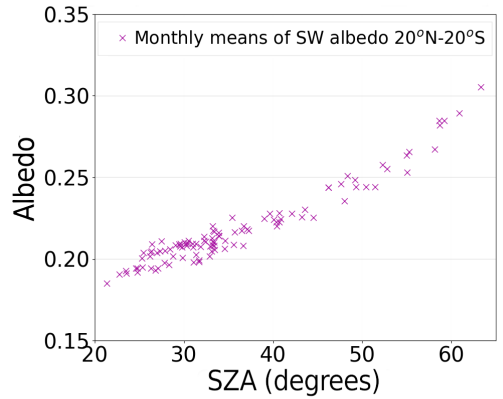


Fig. 4: Differences for an average of December, March, June, September, clear sky fluxes.

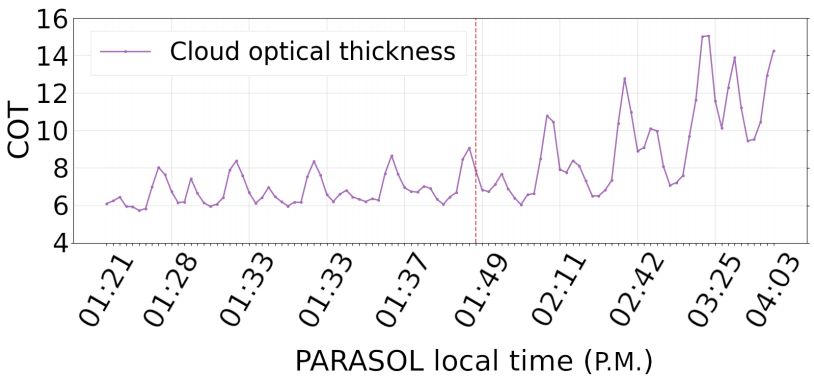
Cloud fraction and cloud optical thickness

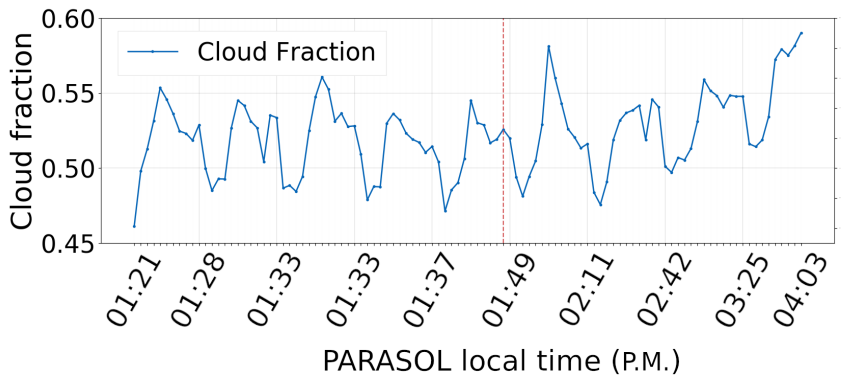
- Albedo increases with SZA





- Cloud fraction and cloud optical thickness increase

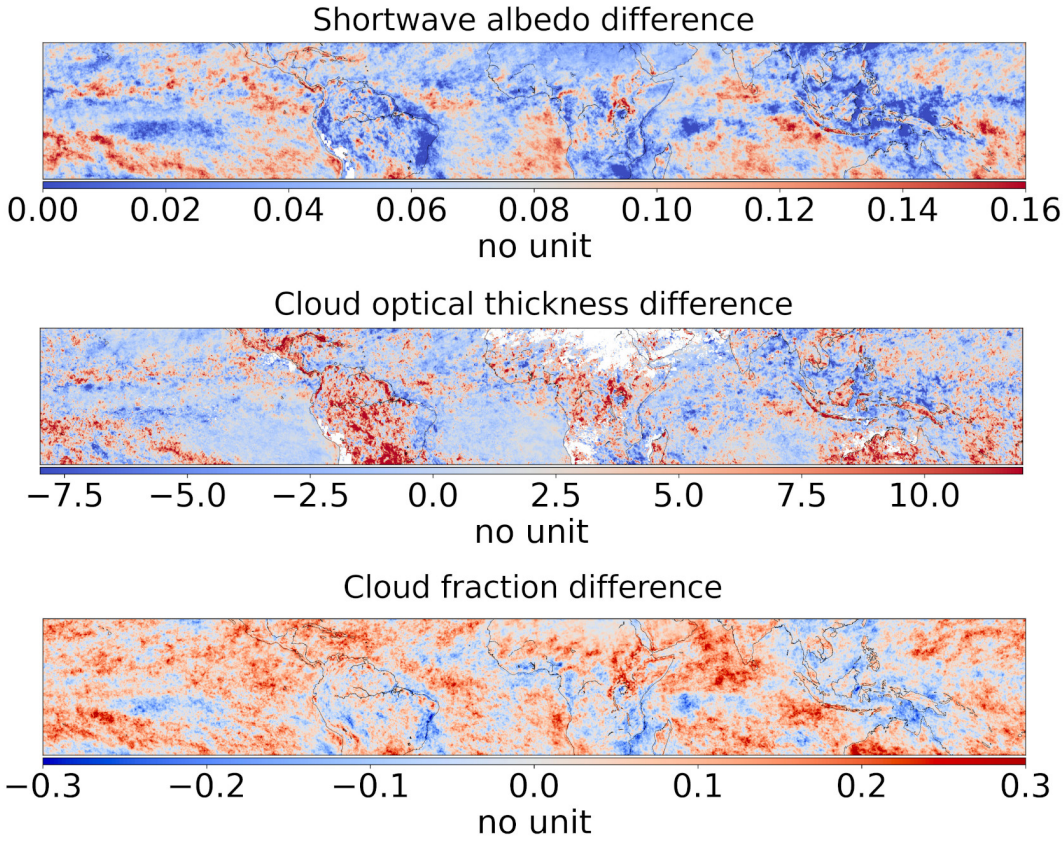




Cloud fraction and cloud optical thickness

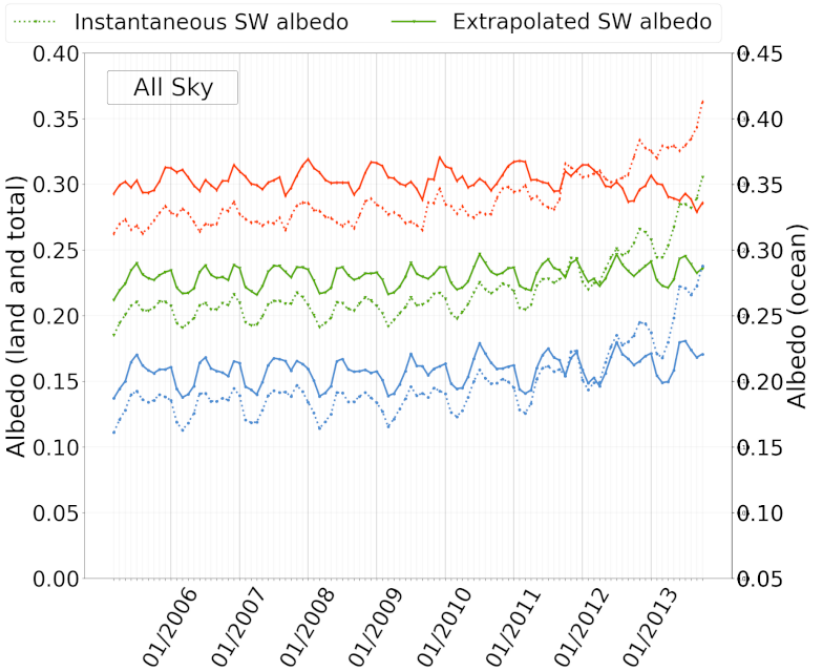
Observations between 3:25 p.m. and 4:01 p.m. minus observations betwen 01:28 p.m. and 01:33 p.m.

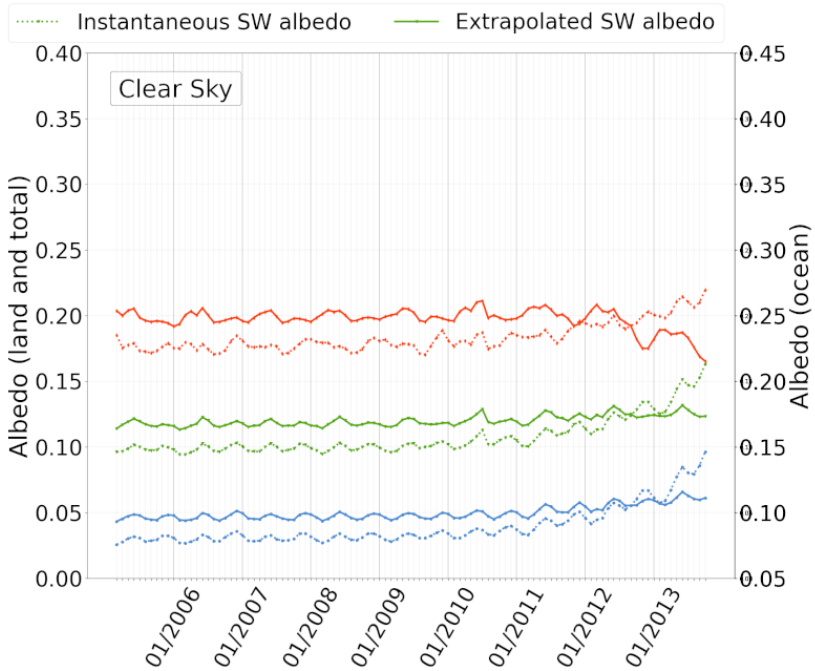
2005/2006 min 2012/2013



- Albedo increases where COT or CF increase;
- Observations at 4PM: thicker clouds (especially over lands), more clouds.

Before and after extrapolation: POLDER





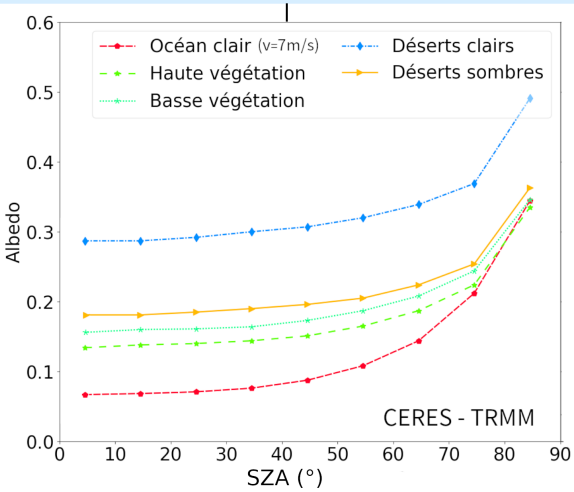
- Diurnal extrapolation reduces the increase of instantaneous albedo;
- Values seem over-attenuated over land but not enough over oceans;
- Happens for all sky and clear sky fluxes

→ Need to investigate the ERBE-like part of POLDER's diurnal extrapolation !

Diurnal extrapolation

CERES SSF_1deg_month

Instantaneous SW albedo

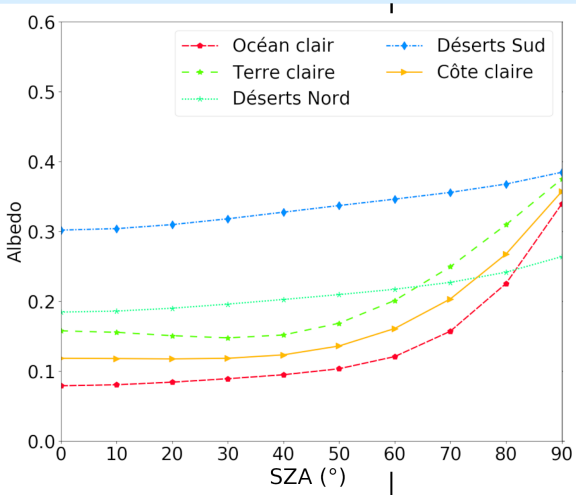


~600 scene types

Monthly means of shortwave fluxes

POLDER RB3

Instantaneous SW albedo



20 scene types

Monthly means of shortwave fluxes

ERBE-like diurnal extrapolation

Only "All Sky"

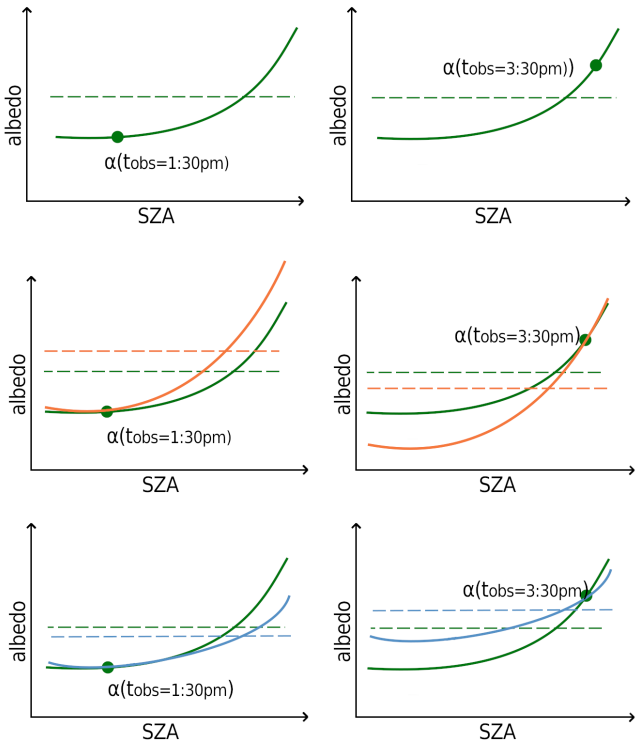
Climatological diurnal extrapolation

5 years of ERBS observations

Viollier et al., 2002

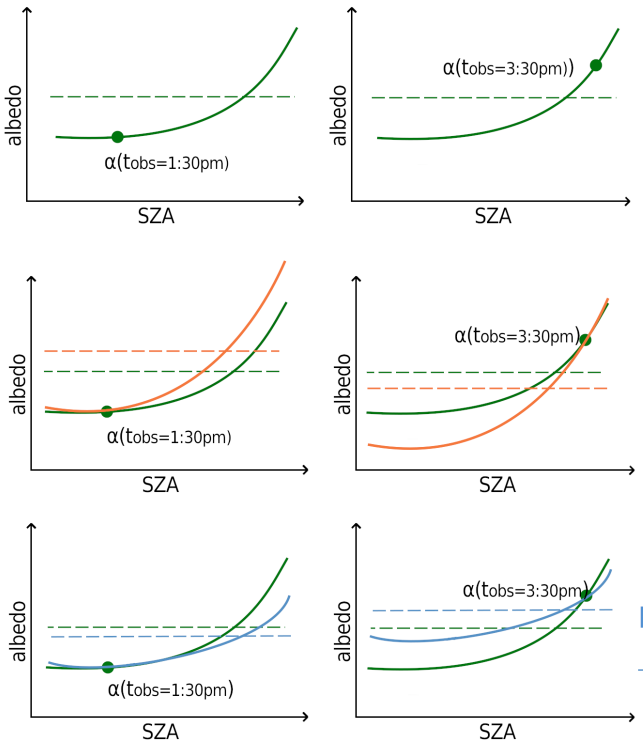
Importance of having precise models

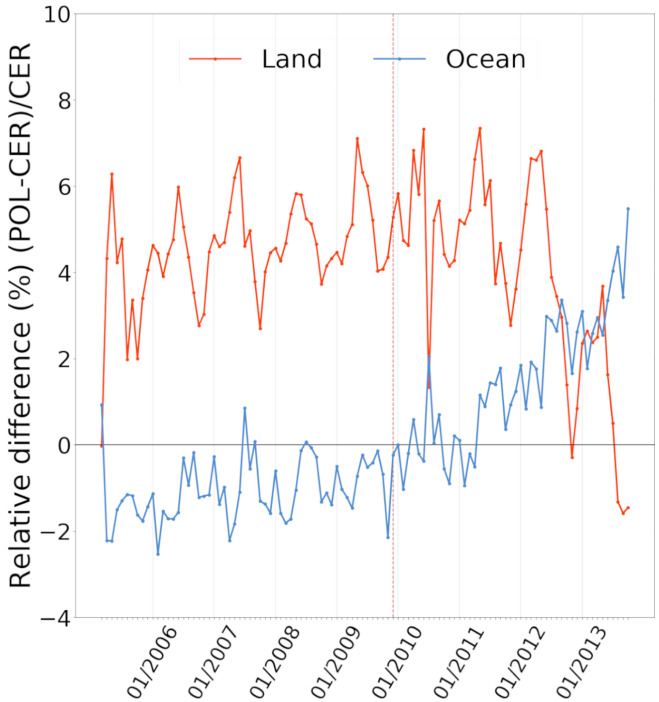
- Importance of having precise albedo models



Importance of having precise models

- Importance of having precise albedo models





Refinement of the albedo models

Using PARASOL drift to refine the models

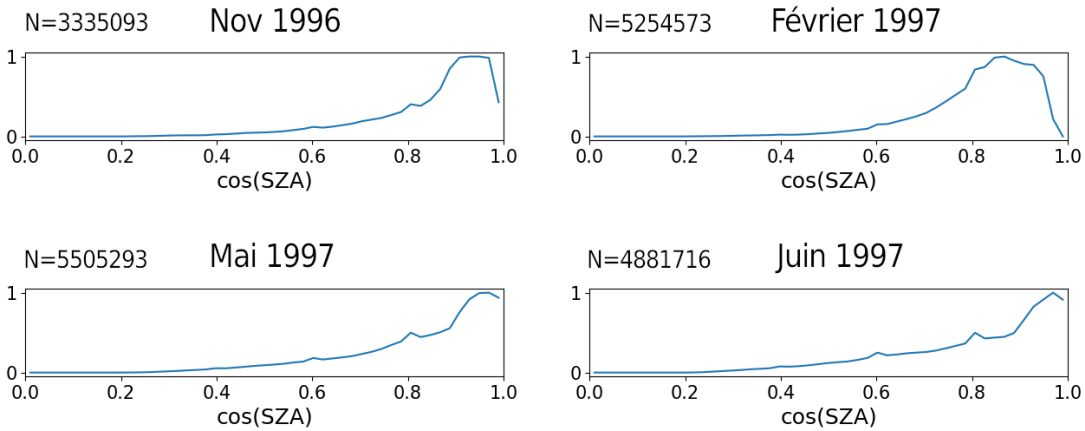
- Current models: 4 months of POLDER-1 observations
- POLDER-1 overpass time: 10:30AM $\rightarrow$ narrow range of SZA
- Drift of PARASOL after 2009 offers a wider range of SZA...why not use it ?

Objectives

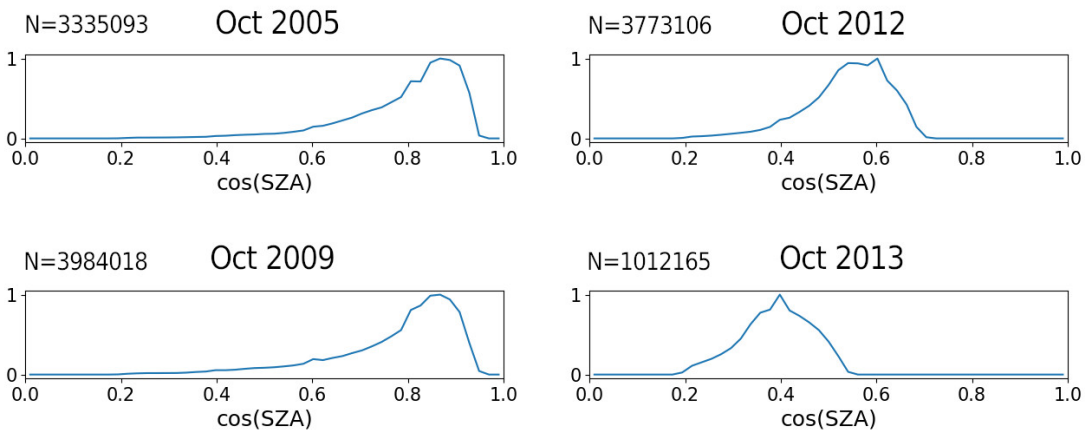
- Obtain models that describe the behaviour of the albedo throughout the day
- Attenuate the increase or decrease of monthly means after 2009
- Get rid of the dependence on the hour of measurement

Interest of using POLDER-3 data

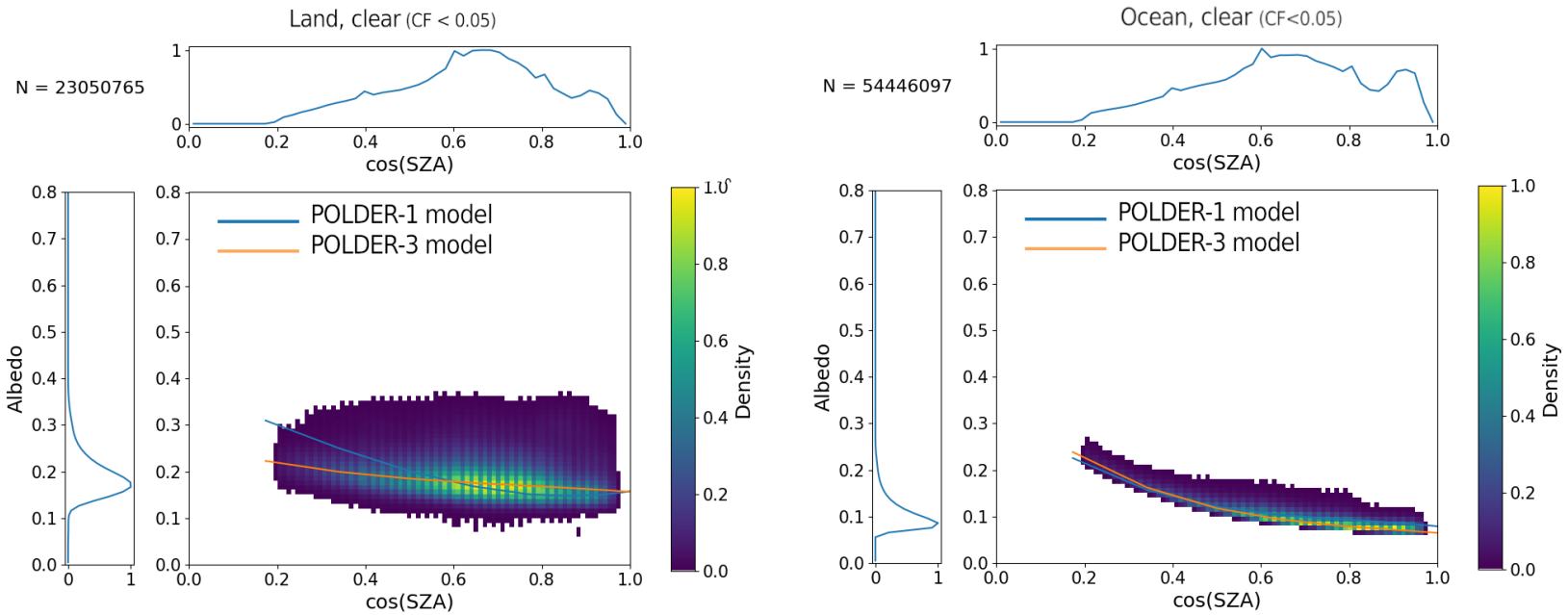
POLDER-1: narrow range of cos(SZA)=μ_0



POLDER-3: extends the range of μ_0

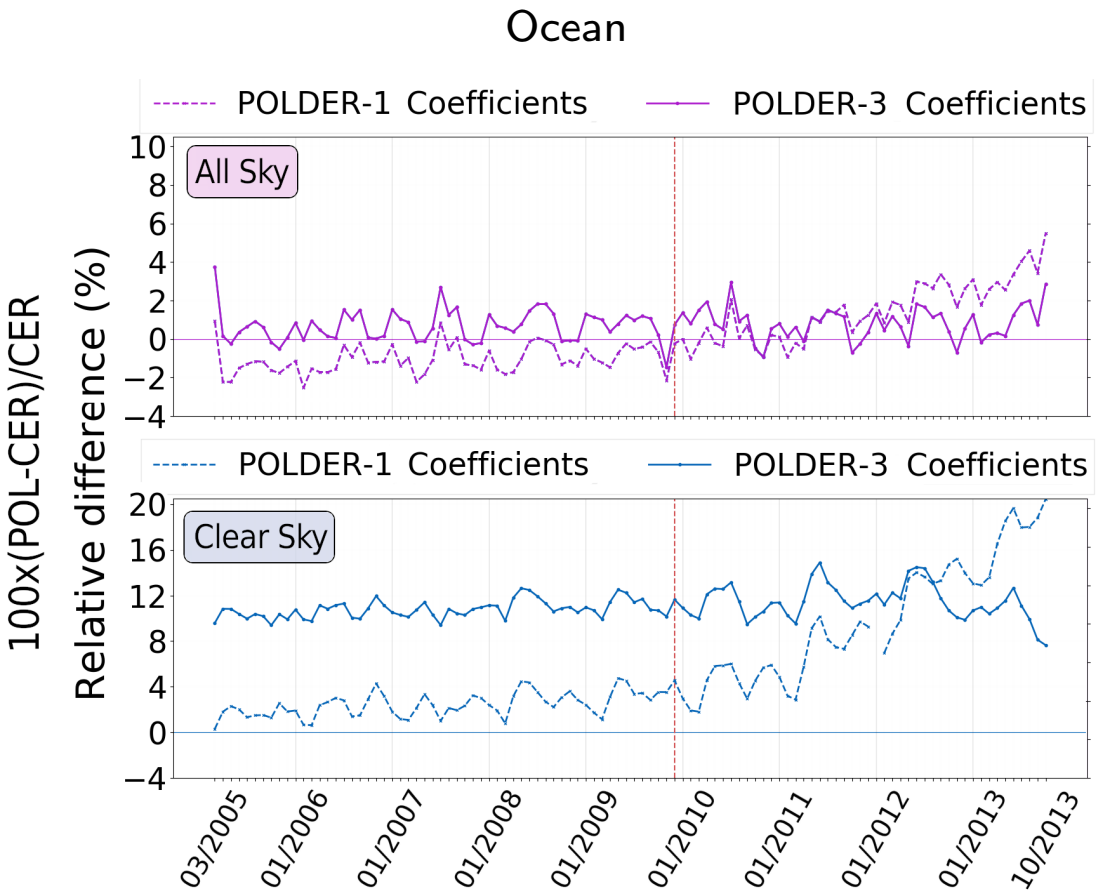


New models: examples



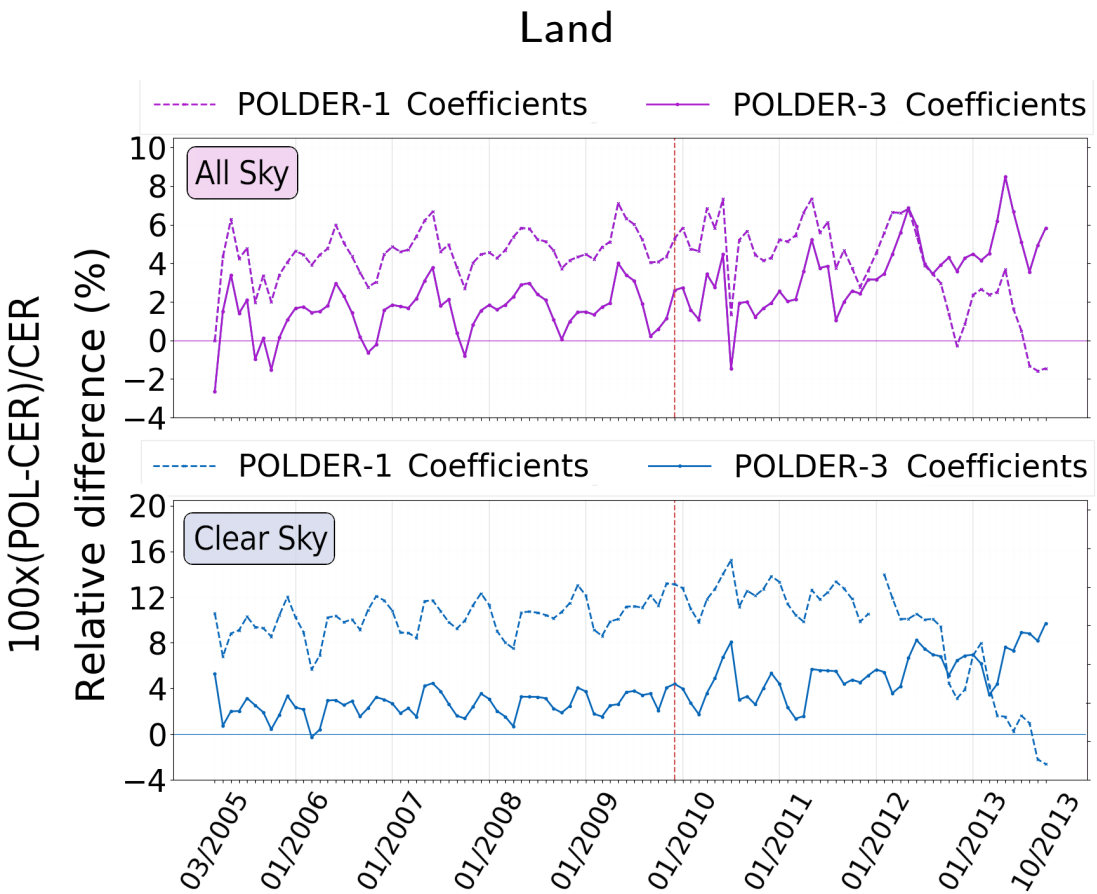
- Wider range of μ_0
- Models applied to POLDER-3 data

New models: relative difference with SSF1deg



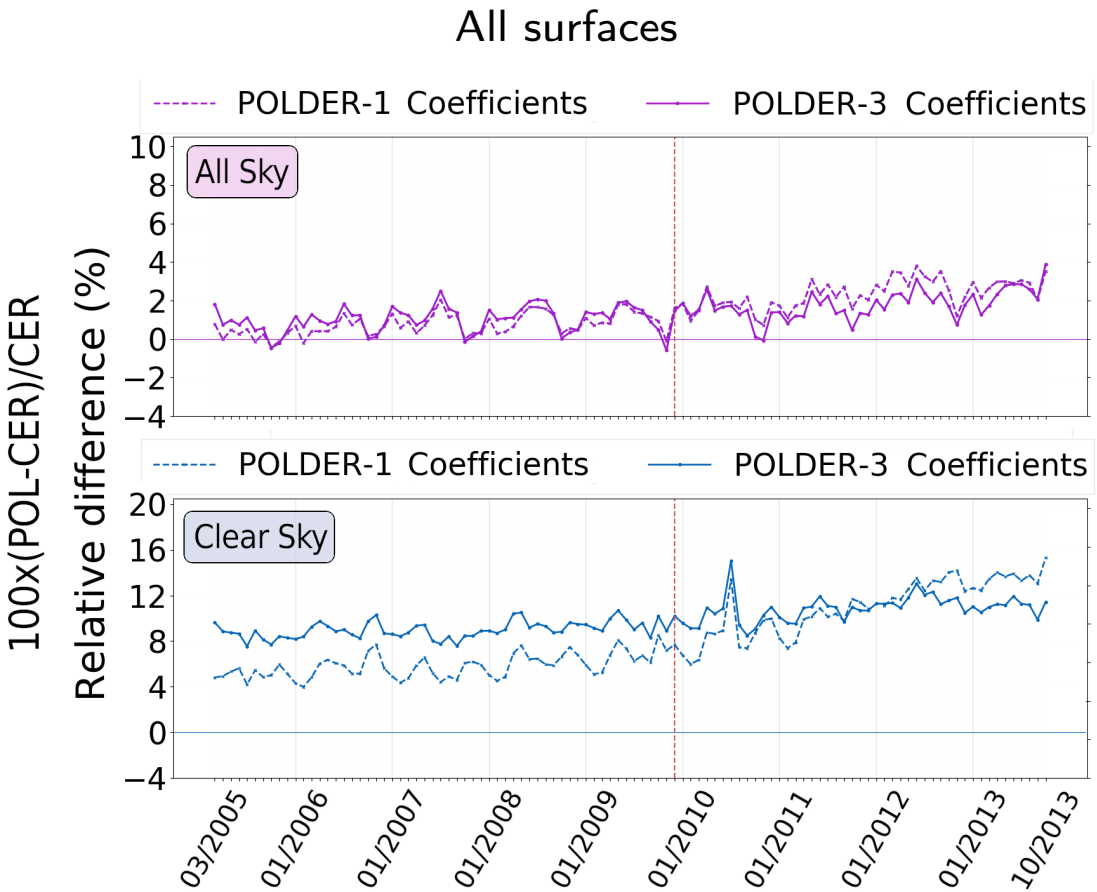
- Monthly means drift less for the all sky case
- Quite stable but drift (decrase) after 2012 for the clear sky case
- In both cases, monthly means increase

New models: relative difference with SSF1deg



- All sky fluxes: monthly means increase instead of decreasing, model too "flat"?
- Clear sky fluxes: also increase, but the drift is less dramatic than before.

New models: relative difference with SSF1deg



- All sky: there is no compensation effect decrase/increase so the monthly means increase;
- Clear sky: slow increase then small decrease after 2012 (from the ocean decrease).

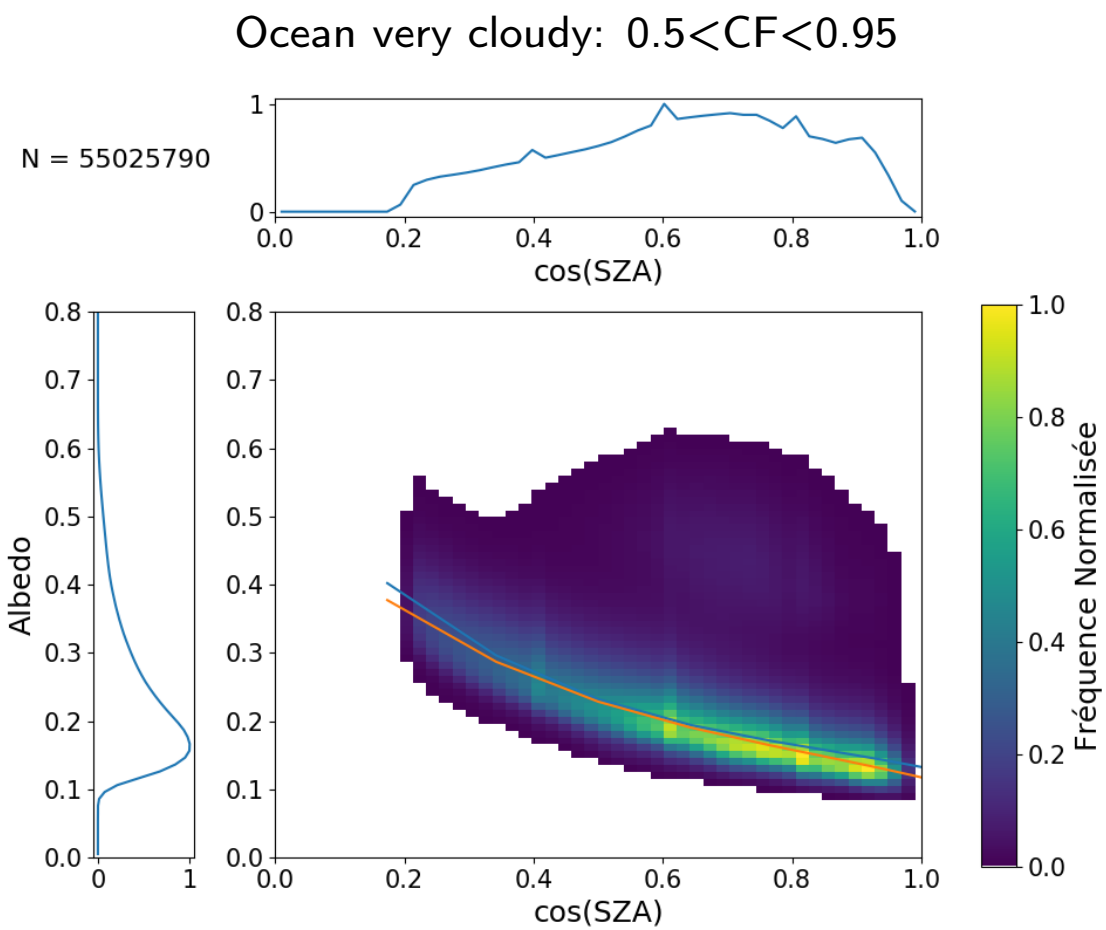
First conclusions

- The new models attenuate the increase/decrease of monthly means of SW fluxes
- Using POLDER/PARASOL data allows a refinement of the models that were in use
- Some scenes still present a drift of values after 2009

Perspectives

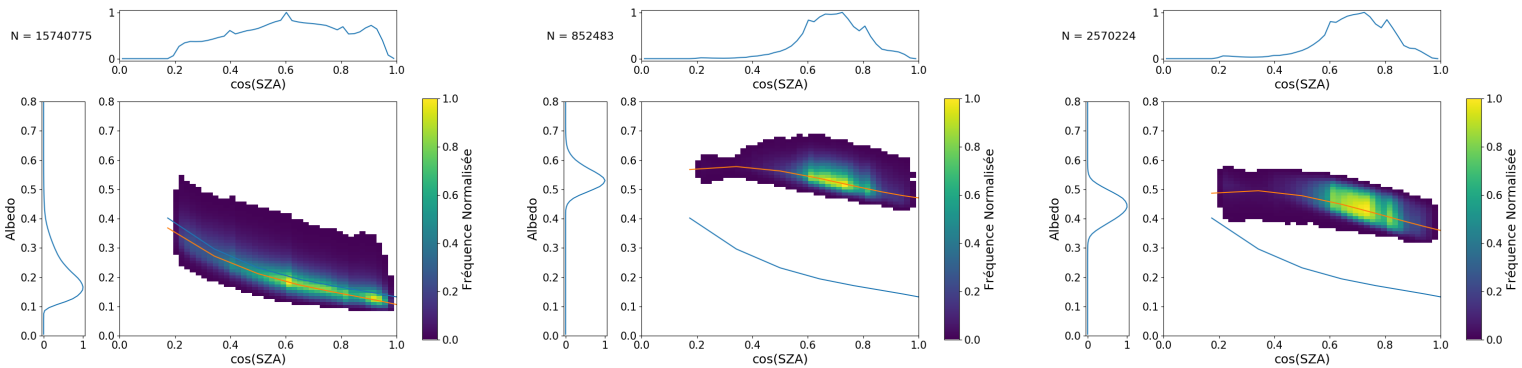
- Identify problem for clear and cloudy land fluxes (NDVI?)
- Increase number of cloudy scenes

Multimodal distributions

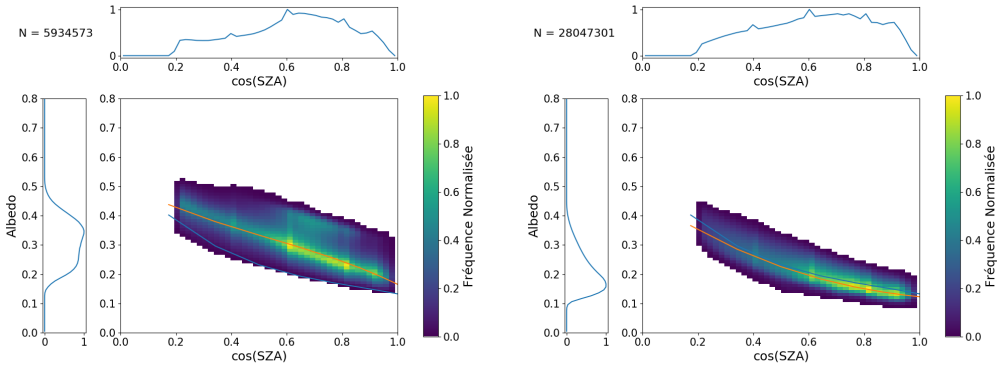


- How to describe such a distribution with only one model ?

New models



Non-liq Liq, very thick Liq, thick



Liq, thin Liq, very thin

Global repartition

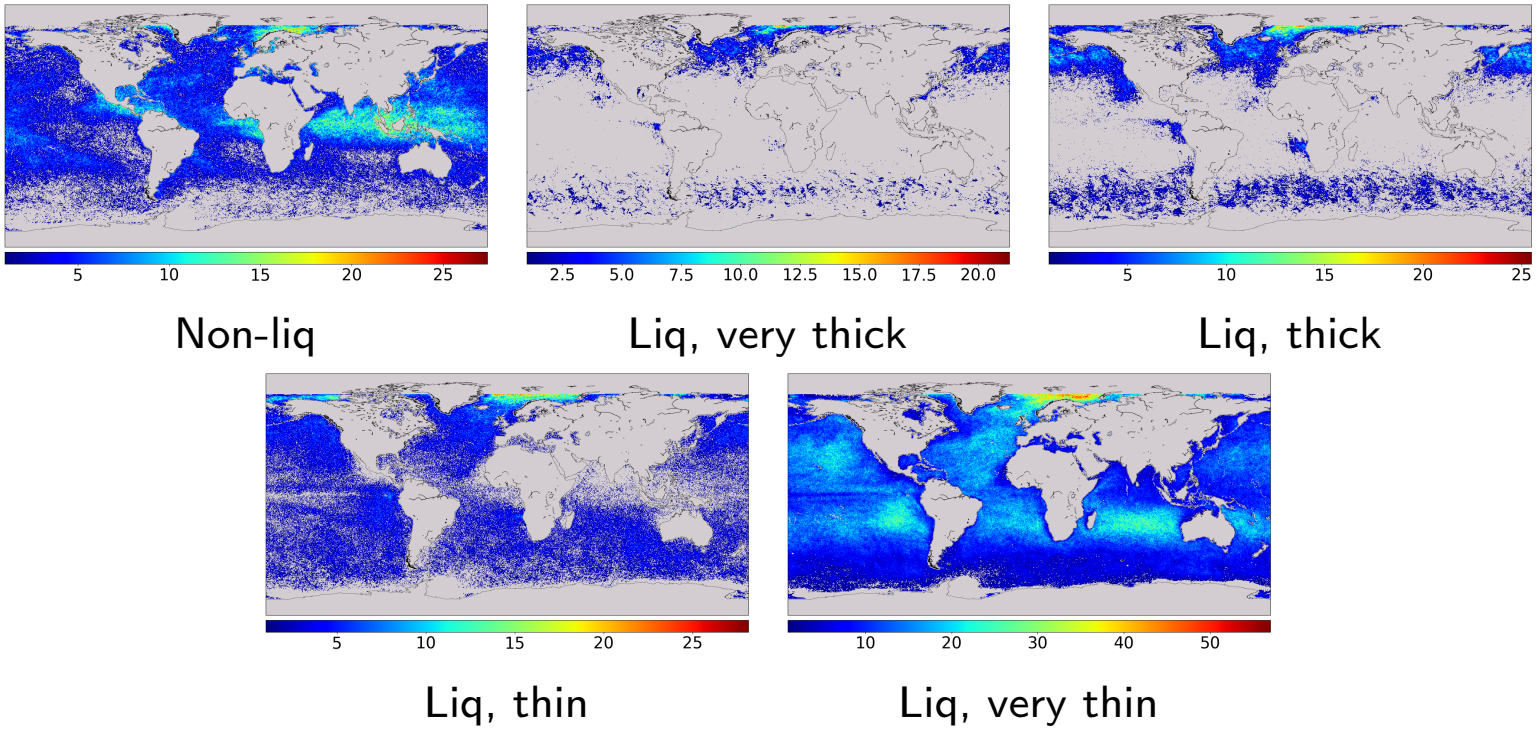
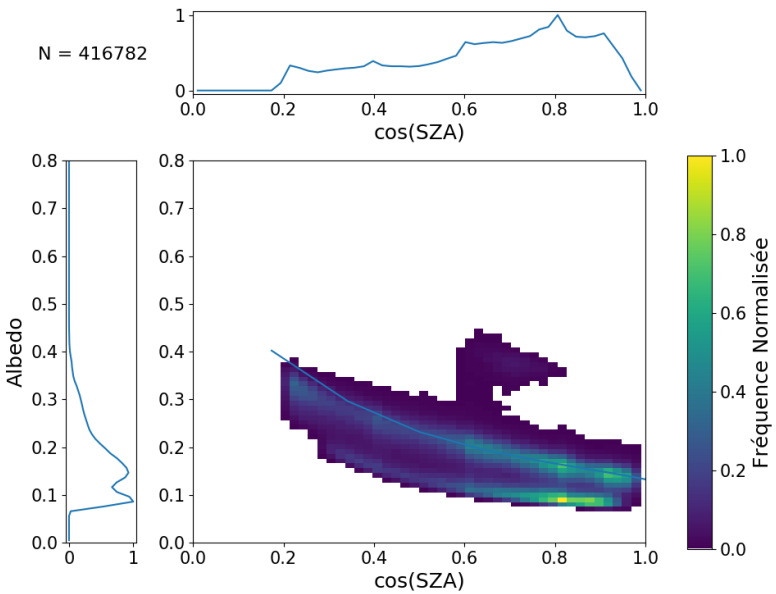


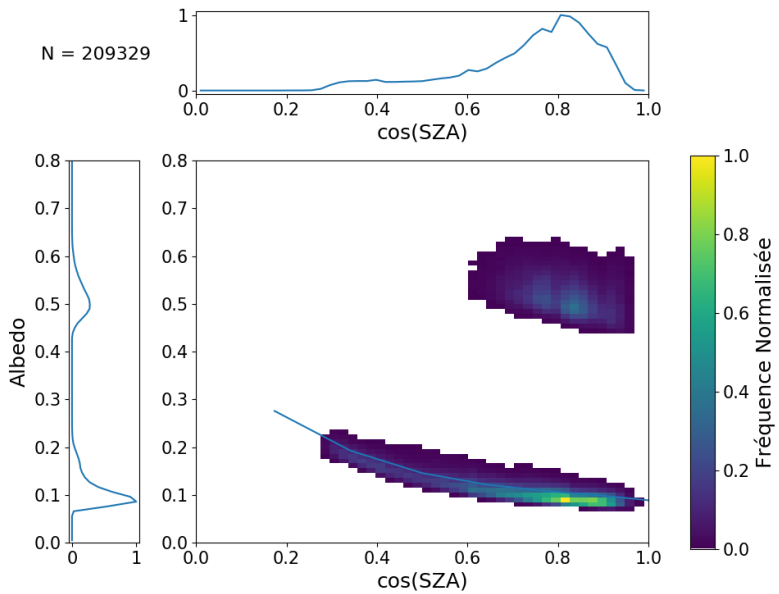
Fig. 5: Number of occurrences for each scene, January to October 2013.

- Most represented on map = P1 models closer to distribution

Problem of identification ?

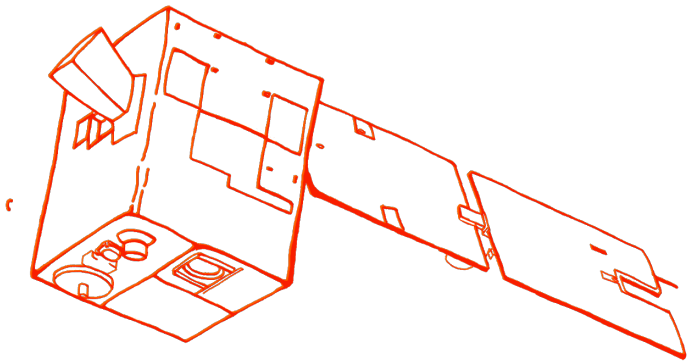


Liq, thin



Liq, very thick

- Multimodal distribution for cloudy ocean (0.05<CF<0.5)
- Intervals too large in COT or CF?
- Problem of scene identification, superpixel too large?



Thank you !

- CERES data were obtained from the NASA Langley Research Center CERES ordering tool at https://ceres.larc.nasa.gov/data/.
- POLDER Data provided by the CNES. We thank the AERIS/ICARE Data and Services Center for providing access to the data used in this study.

Monthly mean RMS flux differen

SYN Terra minus SYN Aqua